Mushroom News

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Vol. VII No. 2 **OCTOBER 1958**

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MYCOLOGICAL
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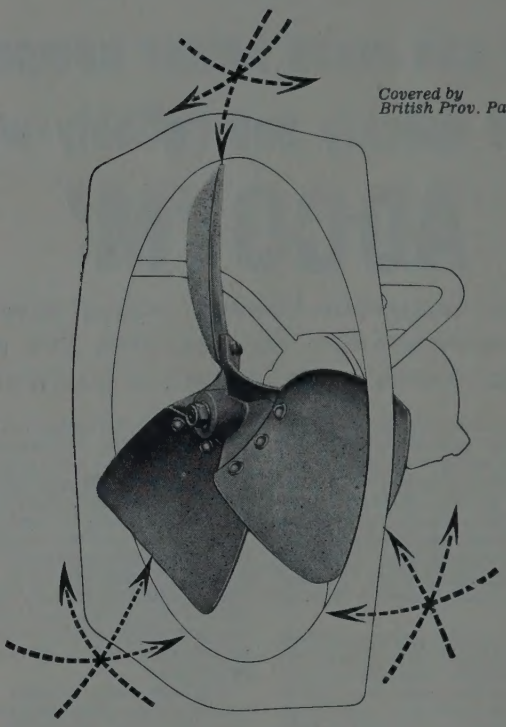

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OUR FRONT COVER

Miss Shirley Baker of Broadham Produce Company Ltd., receives a Second Prize from the Mayor of Bournemouth at the Grand Hotel. They also won three first prizes with their entries.

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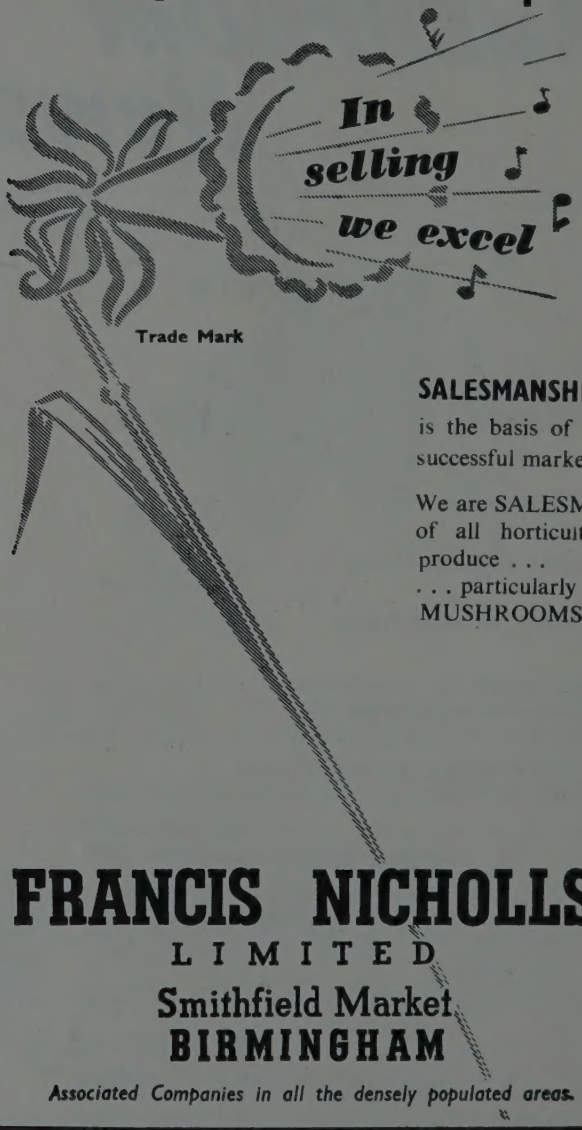

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WORTHING ENGLAND

Vol. VII No. 2 **OCTOBER 1958**

American trends

The visit of Dr. Leon Kneebone of Pennsylvania State University to this country has been one of the most outstanding events in the mushroom world for several years. The Mushroom Growers' Association are to be congratulated upon their initiative in arranging a trip that can do nothing but good to the mushroom industry as a whole.

Later in this journal we give a report on Dr. Kneebone's address to mushroom growers at the meeting at Bournemouth, an address that will provoke a great deal of thought among progressive growers. Here we would like to refer to some of the other, wider matters that Dr. Kneebone spoke about in the course of his visit.

He stated repeatedly that every advance on the cultural side of mushroom growing must be matched by an advance in the merchandising or marketing side of the industry. It is no good producing more mushrooms if nothing is done to advance methods of selling them. In this country we are prone to consider merchandising as limited to publicity to increase demand, whereas the term covers every aspect of the mushroom's story from the moment it is picked to the moment it is eaten, whether the mushroom is fresh, canned or processed. The industry has had a taste of overproduction this summer, and there is no doubt that growers will now give far greater consideration to what happens to their product when it leaves their plant.

Dr. Kneebone said that in the United States the small grower has virtually disappeared from the field, the minimum size of plant being 12,000 square feet. This is the point where mechanisation begins to be an economical proposition, and unit production costs can rise above the average market price during the year. The downward trend in average prices in this country may mean that a similar situation will come about in the not too distant future, although we feel that in the United Kingdom there will always be a place for the small man selling high-quality produce locally. Perhaps this is a matter in which we will not follow the lead of the Americans!

But when Dr. Kneebone spoke of custom composting, he was outlining something that may well prove attractive to a number of growers. In the United States, firms specialise in the production of compost on the grand scale, using the most modern methods and machinery. The compost is then sold to growers and delivered into their houses ready for pasteurisation. In this way the production costs of the

compost are reduced, and a form of standardisation of the material is introduced.

Custom composting has its drawbacks, as Mr. Atkins was quick to point out. The grower who closes down his composting yard and loses his skilled labour, is dependent upon his contractor for supplies. He must take what he is given and must pay the price demanded, or close down his plant, for he is unlikely to find much competition in the field of large-scale composting. Nevertheless, custom composting has its attractions, and it may be the method by which some of the smaller growers will be able to survive.

Dr. Kneebone considers that the mushroom industry as a whole over here is some years behind its American counterpart but the signs show that it is moving in the same direction. Perhaps this is a very good thing indeed, for it will enable growers to study the development of the American industry carefully and make plans well in advance of events so that the many pitfalls can be avoided.

Notes and News

Behind The Iron Curtain

News of mushroom activities in the Soviet block was revealed in an article in a German horticultural trade paper describing a conference held in Moscow at the Agricultural Academy, on mushroom cultivation.

Among those who attended were Dr. W. Arnold of Dieskau, Berlin, and Mr. Imre Heltay of Budapest, both well-known to Western European growers for their contributions to mushroom research.

Russia is becoming increasingly interested in mushroom cultivation, and a number of state farms now grow mushrooms. Two State laboratories are dealing with spawn and spawn research.

Publicity

The M.G.A. is to spend £4,000 on TV. advertising during 1959. This sum amounts to half the estimated income for the year.

Four seven-second spots per week have been booked with Midland ITV. for an experimental fourteen-week period. Before the advertisements commence a survey will be taken of retailers in the Birmingham area, and a second survey will be carried out at the end to see what effect the telecasts have made.

The TV. plugs will be in addition to the small newspaper advertisements now being inserted, and it is intended to widen the range of this form of publicity.

Dr. P. J. Bels of the Dutch Mushroom Research Station (right) about to enter the coach on his way to visit our Experimental Farm.

Dr. Leon Kneebone (second from left) at our Worthing office, with Dr. R. Klein, Mr. H. A. Darlington and Dr. J. Ramsbottom.

Mushroom Imports

Figures of imports of mushrooms from Eire to the United Kingdom show a remarkable increase, commencing in December, 1957, and continuing at a new high rate during the first six months of 1958. The overall increase is approximately 50% of the 1957 total. Comparing prices for the first five months of each of the two years, the average price in 1957 was 3s. 2.33d., and in 1958, 2s. 11.89d.

Production Record

Mr. J. G. Batchelor of Borrow House Mushroom Farm, continues to increase the productivity of his mushroom farm.

One house of 1,265 square feet has yielded 5,920lb. of mushrooms in ten weeks—an average of 4.68lb. per square foot. Mr. Batchelor uses Darlington's 100% Productive White Manure Spawn.

American Short Course

Two hundred and twenty-five mushroom growers gathered at the Pennsylvania State University's College of Agriculture for the Third Mushroom Industry Short Course, held from the 23rd to the 26th June, 1958. Growers from Europe included Mr. Frank Bleazard, Chairman of the M.G.A., Mr. Fred Atkins, who was included in the list of lecturers, Mr. R. D. Dumbreck, Mr. J. Roca from Barcelona, and Mr. C. Riber Rasmussen from Denmark.

The course covered every aspect of mushroom growing. Students had a ninety-minute session in the laboratory, where they studied diseases, weed moulds and abnormalities of the crop, under microscopes. Speakers included Dr. E. B. Lambert, Dr. L. R. Kneebone, Dr. G. F. Somers and Mr. K. G. Morgareidge.

During the course a banquet was held by the American Mushroom Institute, during which Dr. Lambert was awarded the first annual trophy for outstanding service to the mushroom industry. It is intended to make the award an annual event, to be conferred on the person who has done most for the American mushroom industry during the previous twelve months.

New Insecticides

W. F. Barthel and B. H. Alexander, chemists working for the United States Department of Agriculture at Beltsville, have discovered a new range of insecticides that are less toxic to warm-blooded animals than any now in use. The new insecticides are derived from chrysanthemumic acid, a synthetic material similar to an acid found in chrysanthemums

Two of the new insecticides appear to be better than pyrethrum, although they take rather longer to achieve their kill. They have given good results against larvae of the common mosquito, codling moth and other pests.

Profile . . . . .

Dr. LEON R. KNEEBONE

Research Professor at Pennsylvania State University, U.S.A.

To those who attended the Mushroom Industry Exhibition at Bournemouth the name Leon Kneebone will recall a fascinating lecture which more than filled the allotted span, was then continued after an interval and again in the evening, at their wish, or rather, on their insistence. They will have well in mind a sturdy figure of medium height, and a sandy complexion, speaking without hesitancy, with refreshing touches of wit and humour breaking into periods of abounding practical wisdom. Amply illustrated with coloured transparencies it was a model discourse, giving the commercial grower a clear idea of modern American methods and with a good deal of underlying scientific facts. Possibly many of the audience did not realise how much science they absorbed for Kneebone has the uncommon facility amongst scientists of making it sound like common sense.

For many also there will be the recollection of an attractive personality, a good "mixer" (in spite of lack of the stimuli commonly associated with social gatherings!), enjoying the give and take of ideas, and the hurly burly of banter.

Some growers, later, had the pleasure of showing Professor Kneebone over their farms. Here again he impressed with his knowledge of the industry: it is not every professor, moreover, who would bare an arm and plunge it to the elbow in a heap of compost. It is certain that everyone who had contact with him benefited from his visit.

It would be wrong, however, to imagine that Leon Kneebone has a one-track mind. Willing always to discuss mushrooms from any angle, or the wider aspects of mycology and botany, he showed a real interest in this country, regretting that his stay did not permit of wider opportunities to learn by seeing. As it was he managed to get a thrill out of some of the old churches and cathedrals and their historical associations—even, under the expert guidance of F. C. Wood, learning about mason's marks—revelling in the old and the odd, not in guide books but part of our heritage. He looked at the countryside with a discerning eye and an enquiring mind. In company with the President of the Mushroom Growers' Association (Mr. F. Bleazard) I spent a day with him at Kew Gardens and the Rothamsted Experimental Station, a day which seemed to satisfy his craving for science and its historical associations.

The reason for his attitude towards this country is not far to seek

for his mother (née Tucker) is from Torquay and his grandparents are Cornish: it is, therefore, "home" to him in a way we understand and appreciate.

Leon Russell Kneebone was born at Bangor, Pennsylvania, on May 28th, 1920. He attended Bangor High School and passed out with honours in 1938. He then entered Pennsylvania State University and obtained his B.S. with honours in 1942. His academic career was broken into by four years as a paratrooper in New Guinea and the Philippines, where he was severely wounded in the attack on Leyte, the first of the Philippine islands to be taken. After five months in hospital in the Pacific he was discharged, in 1946, with the rank of Captain. Probably if he had not joined the army he would have become a school teacher, but he returned to State College by the aid of a government grant under the G.I. Bill of Rights. There he did graduate studies (i.e., what we term post-graduate) with mycology as his major subject and plant pathology and bacteriology as his minor (or subsidiaries). In 1950 he obtained his doctorate for a thesis on the physiology of the germination of spores of fleshy fungi: the research was carried out under the direction of Professor J. W. Sinden. At that time Professor F. Kern was dean of the graduate school, and within a month of retirement. When I visited State College in 1926, and stayed with Kern, it was then a centre of research on Rust Fungi, a group in which American mycologists were obtaining extremely valuable results on many lines. It is a matter of pride to Kneebone that the last appointment made by this prominent mycologist was to nominate him as an Assistant Professor in charge of Plant Physiology and Basic (i.e. General) Botany. Thus, immediately on obtaining his doctorate his feet were firmly set on the professional ladder, but though he had a training in mycology and had doubtless an awareness of the research on mushrooms which was being carried out in the department, his special subjects were only remotely connected with it. But fortune again took a hand in his career. Professor Sinden in 1952 had a sabbatical year —theoretically a year free from academic duties awarded to a professor every seven years to enable him to keep abreast of modern research by study or by travel— and Kneebone took over his classes. At the end of the year Sinden retired to enter into association with commercial mushroom growing and Kneebone succeeded him as Research Professor in charge of the Mushroom programme (1953). It must have been somewhat of an ordeal to be suddenly planted in a flourishing department as its chief only three years after graduating there. However, he immediately made good, and this he attributes to Sinden's training—the sort of loyalty to one's former chief that is as refreshing as it is rare—but his previous career was such that it was to be expected that he would set about his job with a will. The result has been that in the short space of five years he has gained an outstanding international reputation in both the academical and the practical problems of mushroom growing. In 1956 he started his now well known short course for growers held at State College each June for four days, courses attended by growers from the length and breadth of the U.S.A., with a sprinkling from

overseas. In the three years the average attendance has been well over 200, and the fear is lest they become too successful.

The Research Professorship is not entirely free from lecturing and he has as one of his main tasks the training of graduate students in mushroom research. Five have just obtained their doctorates and are ready to enter the industry. His own research, which is financed by the Federal Government, the State Government and is also subsidised by the mushroom industry, is at present on (1) the improvement and maintenance of strains of spawn, (2) the mechanisms of fruit-body formation, i.e., the factors influencing the initiation and development of mushrooms, (3) nutritional studies on compost, (4) investigation of certain diseases, especially Mummy.

In discussing such matters with him I was impressed with his insight of the fundamental problems which must be solved if mushroom growing is to benefit from scientific research, and was left in no doubt about his enthusiasm.

His visits to some of our leading growers enabled him to compare their methods with those in America and to evaluate the varied practices. Obviously conditions are different for no one here has a stock of stable manure enough for a two years' supply, with a superfluity readily available. He repeatedly alluded to the main points he had brought out so clearly in his lecture:—Composts require adequate water, nutrition and aeration as soon as possible in the composting process, and aeration is especially important throughout composting and peak heat: Beds and trays should be uniformly filled, and levelled, with a homogeneous compost: Uniformity of the casing layer is important and each particular casing material has its own optimum depth and moisture content.

The day before he left for home he said he was favourably struck with what he had seen both of methods and of yields. He rather whimsically added that he had planned to ask and to learn but had found that he had had to do most of the talking, answering questions—"they're certainly keen".

To complete this note on one who has impressed us all so, it seemed to me that amongst the real thrills of his visit that of a transatlantic call home and hearing his wife's voice as in the next room telling him that all was well with her and with their family—a daughter of ten, a son seven and a baby girl of four months—was one of the greatest.

J. RAMSBOTTOM.

MYCOLOGICAL SCIENCE FORAY

A joint meeting of the Société Mycologique de France and the British Mycological Society took place at Reading from September 3rd to 10th, the first time such a meeting has been held here. Over eighty members of the French Society attended including several from Belgium, and a sprinkling from other countries.

The main purpose of the meeting was the collecting of fungi: there was a good "bag" from Windsor Great Park, Aston Wood, New Forest, Blenheim Park and Mortimer, and this was discussed both in the open and in the laboratories where there was a display of the fungi found, and facilities for proper examination.

NURSERY WALK AT WORTHING

The N.A.A.S. organised a Nursery Walk at Messrs. A. G. Linfield's Lyons Farm on 6th August, 1958. A good attendance of growers from the district saw roses, chrysanthemums and, of course, the newly converted mushroom houses.

Messrs. A. G. Linfield, Ltd., were hosts to growers on a NAAS Nursery Walk at their Lyons Farm Nursery, Worthing, on the 6th August, 1958.

The 140-acre nursery has 6¾ acres of glass, mainly in ½-acre blocks, and 30 acres cropped as a market garden unit. The remainder of the land is devoted to general farming. For the glasshouses, mushrooms are the main crop, with carnations, cucumbers and roses as runners-up.

The mushroom unit consists of 24 converted glasshouses, insulated with Bitumen Bonded Fibreglass covered with roofing felt, each house containing 10,000 square feet of cropping area. The compost is prepared at the central composting yard at Thakeham, where the rapid process is followed, pig manure forming the bulk of the raw material.

Upon arrival at Lyons Farm the compost is shredded before filling into trays and conveyed by fork-lift trucks to the special pasteurisation block of six rooms. There they are treated for from 5 to 8 days at an average temperature of 128-130 F. Adjoining the pasteurising rooms are spawn-running rooms, the trays having been through-spawned by a spawning machine. The trays are spawned at about 20 square feet to the carton of grain spawn.

Casing is done mechanically with a mixture of peat and chalk, and the trays are then moved to the growing units. Between crops these units are completely emptied, washed down and then thoroughly heat-sterilised with steam.

The mushroom unit lays down 25,000 square feet per week, on a 9½-week cycle, so giving between five and six crops per year. The mushrooms are marketed through a central sales department at Thakeham, where the Linfield Cannery is installed. While the bulk of the crop is marketed through the usual salesmen in all parts of the country, canning and processing under their own brand names is absorbing an increasing quantity of mushrooms.

Town Hall, Bournemouth

MUSHROOM INDUSTRY EXHIBITION

BOURNEMOUTH

1st—2nd October, 1958

The 1958 Mushroom Industry Exhibition, organised by the Mushroom Growers Association was held in Bournemouth on the 1st and 2nd October. Two lectures were given and are reported in this account of the proceedings at the Exhibition.

GROWERS gathering at Bournemouth for the Annual Mushroom Industry Exhibition had a warm reception from everything but the weather. At times the skies were cloudless and the sun beat down as though to show just what they were missing. Then, in would come the clouds again and at times the rain was tropical in the intensity with which it fell. The streets were flooded and the public gardens displayed large ponds that were certainly not put there by the landscape gardeners.

Despite the risk of being drenched to the skin the moment they left their cars, growers made their way to the Town Hall for the Exhibition, the competitions and the lectures. Many of those who were making a two- or three-day stay, put up at the Grand Hotel, and the staff there rapidly resigned themselves to being taken over by the "mushroom gentlemen".

The Exhibition opened at 10 a.m. on Wednesday, 1st October, and by 10.30 a.m. the large Public Room at the Town Hall was filled with members, their wives and friends. There were twenty trade exhibits, including manure turners, fork-lift trucks and spawning machines ranged down the centre of the hall, and other stands arranged along the walls. The entries for the mushroom

competitions were arranged on a stage at the end of the hall.

Our own stand was furnished as a reception room, and we were pleased to see many of our old friends on it in the course of the two-day show. Growers were especially interested in some aerial photographs of our experimental farm, and also in the new multi-vane fan or "blower" which can be attached to the motor of an existing 15 or 16in. fan, and used with polythene ducting.

At 3 p.m. on the first day, growers attended a lecture by Dr. Leon Kneebone, Professor of Botany at Pennsylvania State University, U.S.A. Admission to the small lecture room was by ticket only, and it was a case of "House Full" notices going out well before the lecture. Dr. Kneebone spoke until twenty minutes to six, and continued later in the ballroom of the Grand Hotel.

Members hurried from the lecture room to the Grand Hotel to be present when the Mayor of Bournemouth presented the prizes in the mushroom competitions. Broadham Produce maintained their usual standard by winning three first prizes, with Mr. G. V. Allen of Bilting taking one first, and Mr. G. R. D. Newell of Amersham, another. The M.G.A. Cup and Mount Cup were won by the Monlough Food Production Co. Ltd., of Northern Ireland.

On the afternoon of the second day, Mr. Fred C. Atkins was the lecturer, and he gave his impressions of the American mushroom industry gleaned during his visit this summer.

A view of our stand, which was set out as a reception room where our staff could meet customers.

Both Dr. Kneebone's and Mr. Atkins' lectures are summarised at length in this issue.

Dr. P. J. Bels of the Dutch Mushroom Research Station, who was visiting the Exhibition with twenty growers, then reported that the construction of the new mushroom houses at the station was proceeding rapidly. He showed slides of the plans of the houses and models of the finished buildings. Just before leaving Holland he had been present at the ceremony when the highest portion of the roof was put into position, and had every hope that work would be finished at an early date. Amidst loud applause he presented Mr. Frank Bleazard and Mr. W. Alderton with boxes of cigars.

Members broke up at 6 p.m. on Thursday night after votes of thanks and congratulations had been recorded to the many organisers. It was announced that the next Exhibition would be at Folkestone, and members went out into the rain hoping that floods would not prevent their return to their mushroom farms!

Dr. Leon Kneebone

After some preliminary remarks, Dr. Kneebone observed that if mushroom growing became too simple, there would no longer be a living in it. In a way, the problems of the grower were a blessing in

disguise inasmuch as they prevented almost everybody taking up growing.

Turning to the composting process, he said that the same basic principles applied to both vast quantities of material and to small experimental piles such as were to be found on research projects, illustrating his point with slides of the enormous compost heaps of the Gaspari Brothers of Pennsylvania, and of small 5cwt. compost heaps at the research station. The same conditions prevail inside the heaps, if the job is being done correctly.

In their original form, the raw materials are not available for mushroom mycelium, and in order to render them available, the composting process is necessary. Effective composting is the preparation of a suitable compost in the minimum time and with the minimum loss of material.

Taking a sectional cut through the compost heap, there was a cool, dry outer shell, and then an area of "fire fang" extending not more than 8 to 10 inches into the heap and reaching the point where temperatures became too high for the mould to grow. Dr. Kneebone stated that in his opinion, temperatures could not go too high in the interior of the compost heap.

The compost required:—

Moisture
Nutrition
Aeration

if the process was to be fulfilled. All the changes that took place during composting were hydrolytic, and required the presence of moisture. It was therefore advantageous to get the moisture into the heap as early as possible so that the processes could commence without delay.

Turning to nutrition, he pointed out that there was no lack of carbon in the compost, the job being to convert the available carbon into a form suitable for mushroom spawn to grow on. In the United States, nitrogen was the limiting factor, and it was now generally accepted that nitrogen must be added as a supplement to the compost in one form or another. The question was, how much nitrogen should be added, and in what form.

In addition to the usual organic supplements, Dr. Kneebone mentioned calcium cyanamide and urea. When adding inorganic supplements it was easy to add too much, leading to loss through ammonia released into the air, and leaching out of the stack. On the other hand, the inorganic supplements were quicker acting than the organic ones, so that more time was required for composting if organics were being used.

Lack of nitrogen slowed down the composting process and American growers were attempting to discover the nitrogen content of their heap at an early stage of composting. The requisite amount of supplement could then be added to provide the correct N value, so that composting could proceed as rapidly as possible. Nitrogen determinations can be carried out by skilled technicians, and analysis of statistics showed that least error in the determination occurred when the sample was taken at the second turn.

Dr. Kneebone emphasised the importance of obtaining as accurate a determination as possible. He had already stressed the fact that too little nitrogen slows down composting, but too much nitrogen leads to additional expense, and the need for a longer period of pasteurisation to drive off the excess ammonia. The target of composting methods

A general view of the Exhibition held in the Public Rooms of the Town Hall, Bournemouth.

must be to reduce the non-productive period—the time from the commencement of composting to the first pick—to the irreducible minimum.

Discussing his third point, aeration of the heap, Dr. Kneebone showed slides of various cross sections of compost heaps. The object was to reduce the area of anaerobic fermentation to the minimum and trials had shown that the best size for a compost heap was six feet wide by seven feet high. In such a heap there is a maximum area of aerobic fermentation with the anaerobic area reduced to a small section at the base. Even this can be removed if a wedge-shaped groove is made at the bottom of the heap by a suitably equipped composting machine.

Dr. Kneebone then dealt with some questions on composting, and in the course of his answers he brought out a number of points of interest to growers. With stiff straw of the Capelle type, he considered pre-wetting to be of vital importance; such straws were deficient in nitrogen, and were tough and difficult to break down. In reply to Mr. Middlebrook he said that the whole composting process could be carried out in the pasteurising house if required, but would be uneconomic, the house being almost permanently occupied carrying out tasks that could be done equally well in the composting yard. He would prefer to fill a compost that was on the green side, so allowing a residual "kick" in the compost to start off the pasteurisation process. He had recently visited a Canadian grower with half a million square feet who used no auxiliary heat for composting, relying entirely upon the residual heating-up powers of his compost to raise the temperature.

Dr. Kneebone then turned to spawning, asking what determined the moment when a compost was ready to spawn. He considered the pH to be the least important factor, quoting the grower who said "Don't confuse me with facts, my mind is made up" The indications of readiness were

Uniformity of growth of heat moulds in the compost,
Loss of Ammonia,
Colour,
Texture.

In comparing composting times, he showed that a wide range occurred in the United States. In the yard, growers composted from 8 days to 28 days, and in the pasteurising house, from 6 days to 16 days. So much depended upon individual conditions prevailing and it would be impossible to lay down any general rules. Depth of fill varied from 4 inches to 11 inches according to the plant, and varied with the length of pick. If the compost was good, then the deeper the bed the greater the pick, although the increase was not proportional—i.e. a double thickness did not yield double the weight of

Mr. Stanley Middlebrook examines a manure turner, assisted by his son.

crop. Once again, it was up to each grower to decide what was best for his own set of conditions.

Of spawn, Dr. Kneebone said that the spawn makers had been the scapegoats of the American mushroom industry for many years. However, while they were not faultless, they were certainly not responsible for many of the sins laid at their door. Selection of spawn strains for commercial cropping was illustrated by a number of slides, showing that the fast-growing spawns did not necessarily prove to be the most productive, but the target of growers must be to use a spawn that gave them maximum production in the shortest possible time.

Dealing with temperatures, Dr. Kneebone illustrated by graphs that the optimum temperature for spawn running is between 72° and 74° F, and that it was better to fall below the optimum than rise above it.

Here Dr. Kneebone digressed to talk about a relatively new phenomenon in the American industry—the custom composter. A compost contractor now does the composting for 50 or more growers in one area and in the Chester County district between 35 to 40% of the growers no longer do their own composting. Custom composting linked with specialised teams who would fill growers' houses, pasteurise the compost and case it, leaving the grower himself only the management and picking of the crops. Composting on a big scale was cheaper and allowed a higher degree of standardisation.

Coming to the casing of the beds, Dr. Kneebone said that of all casing materials now available, he preferred a clay loam. Of the utmost importance, he considered, was maintaining a uniform layer of exactly the same thickness over the beds. Casing by machinery achieved this object, irrespective of the ups and downs in the level of compost. As to time of casing, the sooner the beds were cased, the sooner they would come into crop, but too early casing affected ultimate yield. Nevertheless, early casing could be resorted to in special circumstances where it was important to have mushrooms to meet a certain situation.

Asking what caused pinheads to form, Dr. Kneebone showed a slide of mushrooms grown in a sealed flask, through which air flow was controlled. It was discovered that where the tube air to the bottle came down to casing level, and the exit tube was high up, no pinheads formed. But when the air was drawn out from bed level, and fresh air admitted high up, mushrooms appeared. From this it seemed that the most important thing is to obtain air-flow over the beds at the casing level.

Many experiments had been made to try and discove the function of the casing layer in mushroom growing. Mushrooms had been grown on a casing of pure sand on the one hand,

Mr. Figgis talks with Mr. F. C. Atkins (right) and Mr. Stevens (centre).

and of sterilised, reconstituted spent compost on the other, demonstrating that the nutritional content of the casing did not appear to influence mushroom formation. In the higher plants, fructification is now attributed to concentrations of growth substances at nodal points. Dr. Kneebone suggested that recent work in the United States has shown that fungi, and mushrooms in particular, seem to employ a similar type of mechanism for the formation of fruit bodies. The indications so far are that at a stage prior to the formation of pinheads, there is an accumulation of a substance, and when a critical concentration is reached, the pinhead then develops. If circumstances arise so that the diffusion of this growth substance is too slow (giving a high concentration) or too rapid (giving a low concentration), fruiting does not take place. Complex analytical methods now in use indicate that the substance in question is a hydrocarbon and probably Ethylene.

Fred C. Atkins

Mr. Fred C. Atkins attended the 1958 Short Course for mushroom growers at Pennsylvania State University, and gave his impressions of, and reflections upon, the American mushroom industry.

He said that for several years he had been unhappy about the quality of mushrooms grown and therefore posed the question "What are the factors that determine quality?" He was told at the canneries that the first quality control step is the picking of mushrooms with the root attached and the veil unbroken. In Britain the stalk was cut off altogether, yet the tissue in the stalk is almost the same as in the cap, and it seemed needless to part the two at picking if the retention of the stalk meant that the mushroom retained its fresh appearance longer.

United States growers grow small mushrooms even by our standards. Their second flushes were very small and could go only to the canners, but then the canners wanted only small mushrooms anyway. It was difficult to know who was right in this matter. Mr. Atkins had met two growers who had overcome the small second flush mushrooms and in both cases they cropped at temperatures lower than average. But since both also cropped during the summer months (when most growers take a break) they had good air-conditioning equipment installed and this may be the reason for the larger mushrooms. He had seen excellent mushrooms grown at 50° F. in France and 70° F. in Johannesburg, and it would be misleading to attribute the quality of mushrooms entirely to temperature. He would say, however, that the higher the temperature the greater demands the mushroom makes on its environment, and vice versa.

Mr. Atkins asked how good mushrooms could be kept in good condition, and mentioned that a number of American growers were now washing their mushrooms after picking. Several washing solutions were used, and of them, RONJONITE would shortly be available on the home market. The process consisted of washing the mushrooms and then drying them rapidly, and he advised caution and a trial period before growers launched out on washing plants.

Mr. Atkins said that in the Pennsylvania area, more than 50% of the mushroom crop is canned, and a further 15% is made into soup. He asked growers what they did with rejects, broken mushrooms and so on, and was told that they were chopped up and canned, and were then sold as "stems and pieces". In fact, they had become a best seller, possibly because they were cheaper, possibly because they had a better flavour.

He was shattered at the running costs of canneries in the U.S.A. The M.G.A's estimated of £50,000 was far short of the figure that would be required, and it would cost at least £500,000 to set up a small cannery that would make an impression on the fresh market in Great Britain. Processing, however, was another matter, and here he thought growers should proceed cautiously, exploring new methods of processing and finding new markets.

The Americans do things in a big way, and with the aid of some coloured photographs, Mr. Atkins showed some of the machines they are using to achieve mechanisation in all mushroom growing processes. He mentioned custom-composting—composting by a contractor for resale to growers—as one way of getting round the high wages paid, and the high cost of machines such as the Linfield self-feeding manure turner. He pointed out the danger to small growers who might become dependent on a compost supplier. They would have no guarantee of quality or control over price, and he suggested that the answer might lie in commercial composting, with several growers joining together to purchase one big machine rather than custom-composting.

Mr. Atkins mentioned that U.S. growers were employing graduates from Pennsylvania State University in increasing numbers, so that the American industry now had a leavening of qualified scientists. In this country Mr. Toovey of the G.C.R.I. would like to see a similar movement take place, but was sceptical as to whether the British industry would absorb graduates.

Finally, Mr. Atkins referred to the Knaust Brothers Project in the New York area. They compost for two to three days in the open, and then fill into their houses for two-phase pasteurisation. They already had a scheme on paper for complete mechanisation of the composting process. The dry ingredients of their synthetic compost would be stored in silos, and would be disgorged into a worm conveyor. The final silo in line would contain finely-chaffed straw, capable of absorbing three times its own weight of water. The ingredients would be moved along by the worm conveyor and would energe at the far end thoroughly intermixed and ready for filling into pasteurising rooms for controlled composting. It was hoped by this method to reduce a 48-man composting operation to a process controlled by one man pressing buttons.

PESTS OF THE CULTIVATED MUSHROOM

No. 3 –The Pests Themselves

by

Martin D. Austin

In this, his third article in the series "Pests of the Cultivated Mushroom", Martin D. Austin turns to specific pests and deals with flies, both Sciarid and Phorid, describing their life-cycle and giving suggestions as to the best way of combating them.

There are, unfortunately, a number of pests of cultivated mushrooms, each of which is capable of causing serious injury, and indeed, in many instances, considerable loss of crop. Sometimes a single pest species occurs more or less on its own, but in large enough concentrations as to be of real economic importance. At other times, a number of pest species occur together. Thus, although it is academically easy to define the relative status of the individual pests, their importance on a particular farm, or in certain localities, may vary a good deal.

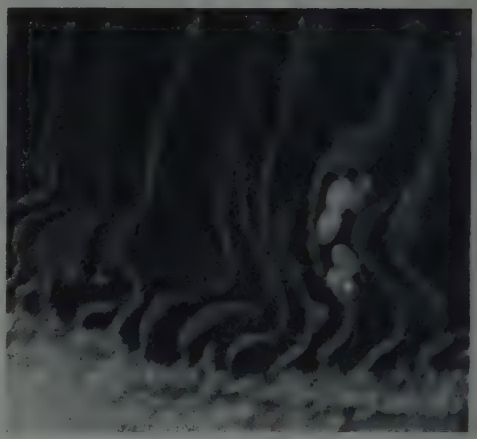
Some years ago, Jary—Ann. App. Biol. XXI, pp 162-167—classified mushroom pests into three groups, each largely separable from the others on account of some notable source from whence they came. This approach to pest classification conveniently identified the groups which are in fact still the basis of determining pest status in the most recent issue of Ministry of Agriculture Bulletin 34.

Stated simply, some pests may be quite normal to particular situations: *buildings*—especially when these are quite old, dark, damp, and, not originally designed for mushroom growing: *sites* — where organic material of many kinds has long accumulated and, perhaps most important, a pest complex leading to pest perpetuation sometimes particularly associated with *sites* which year after year have been used for mushroom cultivation. Certain pests are frequently introduced to the site in the manure, or in the casing medium, more particularly if it is soil.

Finally, a number of pests are specific to fungi and may well be attracted to the cultivated mushroom crop in its various stages from spawning to the end of cropping.

Since pest species do not necessarily 'keep to the rules', as indicated above, in some localities one or more pest species may in fact belong to more than one of the above groups.

Of the pests known to be *injurious* to cultivated mushrooms, the follow-



Eggs of Sciarid Fly on gills of mushroom (x19)

ing are almost certain to occur, sooner or later, in large or small numbers, even in mushrooms units where preventative and routine control measures are followed:

I. *Flies.*
   a. *Sciarids*, b. *Phorids*, c. *Cecids.*
II. *Springtails.*
III. *Mites.*
IV. *Eelworms.*
V. Other minor pests.

From now onwards we shall largely be concerned with a consideration of each of the above in turn.

I. Flies.

(a) *Sciarids.* This is the common name given to those species belonging to the Mycetophilid genus *Sciara*, many of which attack various glasshouse plants. Of those occurring in association with cultivated mushrooms in this country at least some six have been identified, and an account of one species *Sciara fenestralis*, will well serve as a generalised pattern for the others.

A grower must often base identification on his examination of any fly pest present in the mushroom unit solely on larval characteristics, and it is fortunate that Sciarid larvae are not readily confused with those of other flies. They are legless —this being true of *all* fly larvae— white, with the exception of the head end, which is shining black,a feature which distinguishes these maggots from those of Phorids and Cecids.

On a close inspection of these slender larvae—which are relatively minute during the first few days of their life but eventually at maturity attain a length of approximately 1/5th of an inch—it will generally be found that an almost continuous dark blackish line extends centrally down most of the length of the body. This is the alimentary tract, which is clearly visible when it contains food as the larval skin is relatively transparent.

This larval or maggot stage, which is the active feeding and growing phase of Sciarids' life-cycle, generally covers a period of some two or three weeks. When larval maturity is reached, some two or three days are spent in preparing a neat silken cocoon, sometimes together with soil particles, within which the maggot pupates. The pupae occur in a variety of situations, including the soil or other casing material, between the gills of mushrooms, and also in the larval feeding tunnels within mushrooms.

The pupal stage, which is an intermediate phase in the life-cycle during which the larva is changed or transformed into the future adult Sciarid, may last from one to two weeks.

(a) SCIARID FLIES. Dark in colour about ⅛in. long, often seen running about over the beds. Life-cycle occupies 4-6 weeks Larvae are creamy white, legless maggots having a small hard BLACK head, and when fully grown are almost ¼in. long. Larvae tunnel into mushrooms.

(b) PHORID FLIES. Small dark flies, about the same size as Sciarids, but with stouter bodies and shorter wings. Phorid larvae may be distinguished at once from Sciarids, by the fact that the Phorids do NOT possess the definite black head which is easily seen in the Sciarids.

On emergence from the pupae, the adults may appear to be almost wingless, but within a few hours the wings are fully expanded. These flies, which have only one pair of wings, and are freely attracted to light and congregate on windows and vents, are rather fragile in appearance, have blackish heads. The front portion of the body is also black, whereas the abdomen may be brownish in appearance. The antennae or feelers are long and slender. There are both male and female Sciarids, the latter generally being relatively larger than the males, particularly should the abdomen be distended with eggs.

Pairing may take place within a few hours of the flies' emergence from the pupae, and egg-laying generally commences some two or three days later.

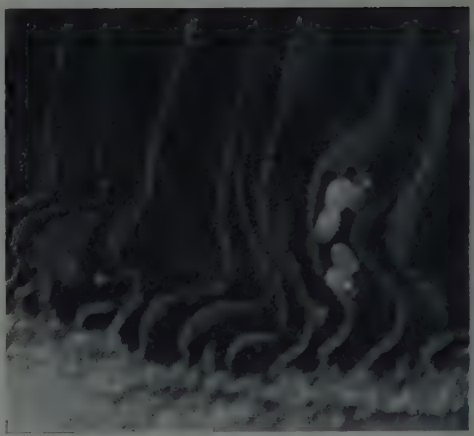
The eggs are very minute, white to transparent and oval, and may be laid singly, in small groups, or in 'strings' or 'chains' of from four to twelve in number. From twenty-five to thirty eggs can be laid by each female whose life usually covers a period of at least a week.

The eggs, which are laid on the casing material, and on cut stalks, hatch within four to seven days. Thus the effective life-cycle of the Sciarid is relatively short—somewhere about a month. It is because of this that a massive and damaging population can build up within the life of a mushroom bed. Sciarids in all stages—eggs, larvae, pupae, and adults—can be present at one and the same time, and conditions approaching continuous infestation of the beds may well occur. This is brought about by an overlapping of *Sciara* generations, and tends to make their control occasionally difficult.

Since Sciarids occur in a variety of situations, particularly where organic matter accumulates, as well as in glasshouses where the larvae sometimes attack the root systems of various plants, they occur almost everywhere in nature. They feed on various 'wild' fungi, and are commonly attracted to manure heaps, thus they are introduced with or attracted to mushroom compost in all of its phases. There is also no doubt that the spawn 'run' itself attracts them, thus, in the absence of preventative control measures, the mushroom crop is always liable to their attentions.

The larvae are fairly active, and can move freely downwards to the spawn and the growing mycelium itself, and once there feed to such purpose that the production of buttons can be arrested and even prevented.

However, the most obvious damage caused is to the mushrooms. They tunnel up into both stalks and



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caps, and spoilage and wastage can be alarmingly severe.

The presence of but a few, say three or four, larvae, can render unmarketable a single mushroom, thus where the overall Sciarid infestation is heavy, a very high proportion of a flush may be found to be attacked and, therefore, useless. In fact some mushrooms may be so riddled or honeycombed with tunnels that the stalks may collapse.

Further, the spread of bacterial contamination and fungus troubles by these flies may well lead to a far too early termination of the cropping life of a mushroom unit. Sciarids have also been noted as agents in the spread of certain Mite species.

Nowadays Sciarid flies are so readily controlled with one or more of a range of insecticides that many growers would suggest that these insects are seldom injurious to the degree that they once were. However, the fact remains that serious attacks are still experienced and, in view of the fact that they cause damage "two ways"—to borrow a modern expression—the presence of Sciarids in mushroom units should not long be tolerated, neither should there be tolerance towards slackening off in the standard of hygiene in and around mushroom houses. For instance, the rapid and routine complete disposal of mushroom waste is vital: should it be allowed to accumulate it but serves as a fertile breeding site for many flies, notably Sciarids. Portions of the base of individual mushrooms are sometimes left in the bed at picking: such pieces should be removed.

It is obvious also that where trimming, grading and packing of mushrooms is actually undertaken in the cropping unit itself special care should be taken to eliminate the possibility of broken or pest-damaged mushrooms, trimmings and stalk pieces and the like, remaining uncollected within the building.

We would suggest that wherever rules of hygiene are strictly followed as a matter of routine, any necessary chemical control measures are the more likely to be completely successful. This is particularly so in connexion with Sciarid control, for if their potential breeding grounds are much reduced there is then little likelihood of populations becoming massive and out-of-hand. Large populations may be very difficult or even unmanageable without a number of sprayings to check them.

In fact, any preventative measures must pay off well: thus, screening of vents or windows, the use of double-doors and sticky traps, to name but three methods, should do much to prevent the effective entry of Sciarids into cropping units.

However, the most important method of coping with Sciarids is by the use of chemical control methods, step by step, dealing in turn with the incoming manure, the compost in some of its stages, the beds or trays before casing is undertaken, during the cropping period, and, last, but by no means least, during the interval—be it short or long—between the use of a particular building.

Although generally Sciarids, in their various stages, are not exactly plentiful in the incoming manure, even a few therein could well form the nucleus of quite a large population. However, those few brought in, together with the many sometimes attracted to the manure when once on the mushroom farm, can be largely eliminated during the earlier stages of composting by the rising temperatures of the compost heap.

Nevertheless chemical treatment of the compost is frequently resorted to, and has in fact been shown to be so extremely beneficial that on many farms it is an essential part of routine.

For instance, B.H.C. dust (containing 5% Benzene hexachloride) or Lindane Dust worked into the compost, at the rate of 6 lbs. per ton of compost, at its final turn, does much to ensure that when the compost is taken into the cropping unit it shall be fly and larva free. So too a 6% Nicotine dust applied to the outside of compost heaps at the last two or three turnings, when the temperature of the heap is high, is good practice, in that it is a good killer of Mushroom Flies.

Similarly, a suitable Nicotine (95-96%) spray, can be used at the rate of one oz. per gallon with one oz. salt, for controlling Sciarids coming to the surface of the compost heap, particularly just before the final turn.

In some circumstances, the employment of a DDT Wettable preparation, as in a DDT plus Basudin mix, as a form of insecticidal whiting, has a real place in the Mushroom economy when used on interior walls of mushroom buildings, including composting units and cropping houses.

The chemical treatment of the compost immediately after it has been laid down as beds, and before casing, is a matter which has received considerable attention and, on many farms, is looked upon as a vital part of a pest control programme. This is a particularly satisfactory point in the mushroom growing process to use certain insecticides, since, where the peak heat achieved is really worthwhile, materials such as Basudin, will relentlessly kill off any fly stages which have survived the composting processes.

Peak heating, whilst killing off many pests, drives others to the surface of the compost, and it is perhaps a matter of commonsense that these should then be dealt with.

For this reason it is suggested, and in fact has been borne out in practice, that the use of certain insecticidal smokes might well be useful. However, whatever insecticide is here employed, its usefulness would almost certainly be enhanced should it be applied just before peak heat.

The use of a nicotine dust or spray at the above period is recommended and has met with considerable success.

It is noteworthy that the maximum killing effect of many insecticides at this point, and indeed later in progress of the beds towards cropping, is obtained at those periods when the temperature is rising. Thus a general recommendation deliberately to raise the temperature of a house to 60°F. just prior to the use of such materials as Basudin and Lindane dusts has a very solid practical foundation.

It must here be pointed out that the range of materials available for mushroom pest control is considerable, and, of course, likely to be much enlarged. For flies, in various stages, including those of the Sciarids, the possibilities of Parathion, Malathion and Basudin are considerable, but a limiting factor in connection with their use, particularly on some farms, could be the toxic hazards which, however, are well covered by following the official regulations safeguarding personnel involved in their use.

Once the process of casing has been completed, the practical approach to Sciarid control is con-

A mushroom cut in half; that on the right shows Sciarid Larvae and the injury they cause.

fined to mopping up the adult flies whenever possible in an attempt to prevent the mass laying of eggs and the subsequent build-up of larval populations. To this end the periodic use of sprays, dusts, smokes, aerosols and the like is resorted to.

It is generally desirable when dealing with pests after the initiation of cropping, to ensure that all mushrooms are picked before applying chemical controls, since some materials, including nicotine sprays, may bring about some degree of discoloration of the mushrooms. Further, even with dusts, there may be some undesirable deposition of the material on the crop.

Following the use of insecticidal dusts, the normal watering or damping down of the beds does much to carry the toxic material downwards, and into contact with Sciarid larvae: further some materials used are said to actually encourage the larvae of many fly species to come to the bed surface where they are then much more vulnerable to control measures.

Whatever chemical is employed during the cropping life of a mushroom unit, it appears to be worthwhile to 'ring the changes', thus, for instance, it is recommended that the employment of Basudin dust should alternate with, say, Lindane dust.

Where dusts are difficult to apply properly, as is sometimes the case where the tray tier system obtains, an aerosol or smoke, such as Basudin or Agrocide No. 23, gives very satisfactory results.

It is as well, whenever planning control measures against very mobile pests, such as Sciarid flies, to use, at least occasionally, some material that is not only toxic to the flies or their larvae at the time of its application, but in fact also has an effective and persistent residual effect. This is indeed a very desirable quality which to a degree is achieved by many commonly employed chemicals, notably BHC, Lindane and Basudin.

Since we are here concerned solely with the control of Sciarids attacking mushrooms, we must point out finally that their control, although not always a simple matter, can in fact usually be brought about readily by anticipating the probable weight of an attack and the risks associated with a particular farm, and then setting in motion the machinery of routine control measures based on the general recommendations given in this account.

Finally, a grower must always have the succeeding crop in mind, the proper cleansing of a mushroom unit immediately after one crop is at its end is vital. Careful disposal of casing media and compost and crop remains, together with 'cooking out' by steam heat, the use of a sterilising agent such as ECA.-55, or possibly a fumigation with sulphur dioxide, will do much to ensure that the unit will be fly-free, and thus in a suitable condition for re-cropping.

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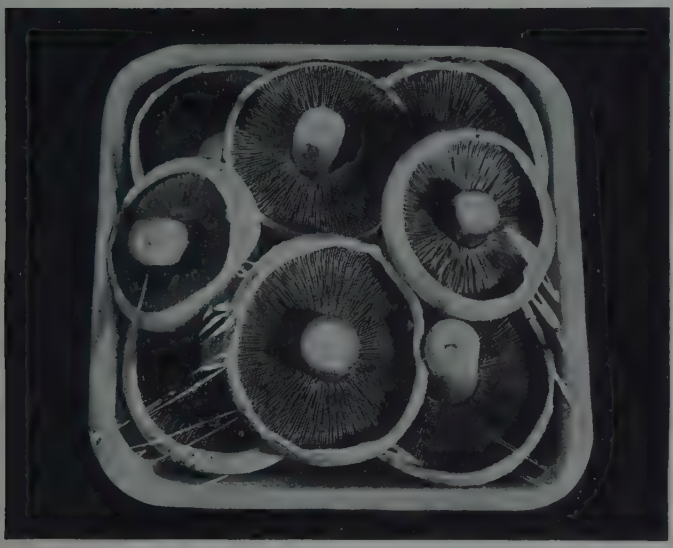

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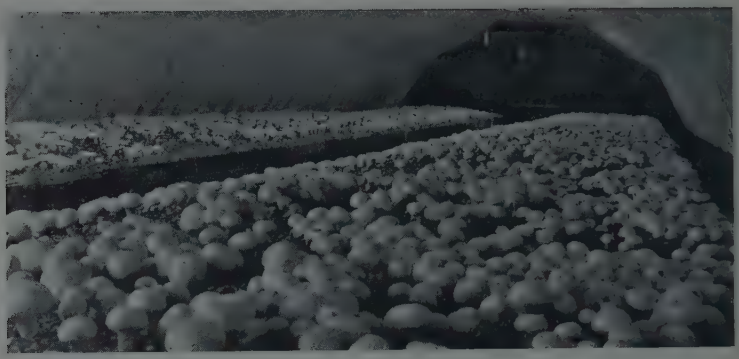

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JAMES HODGSON, Brook Street, Wakefield. Tel.: Wakefield 2894. Telegrams: Radish

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